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(54) IMPROVEMENTS IN HELMET-MOUNTED SIGHTS

(71) We, HAWKER SIDDELEY AVIATION LIMITED, a British Company of Richmond Road, Kingston-Upon-Thames, Surrey KT2 5QS, England, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:

This invention is concerned with helmet-mounted sights such as are employed in modern navigation/attack systems for aircraft.

Known helmet-mounted sights employ a fixed reticle with which the pilot can designate targets and thus be able to direct both his aircraft and missile sensors to a point at which he is looking.

The pilot's line of sight through the reticle is determined by a sight surveying system from which is computed the position of the helmet and thus the line of sight of the pilot for target designation to the navigation/attack system. Target image displayed on a cathode ray tube may be transferred by optical means on to a partially reflecting parabolic section of the helmet visor to present a collimated display visible to the pilot and superimposed on the real world seen through the visor.

There are certain shortcomings in the accuracy of this system due, in one respect, to its dependence on the attitude of the human head which is unbalanced and therefore subject to the effects of vibration and acceleration, making it extremely difficult to hold the reticle, or aiming spot, exactly on target which may move randomly about in response to the varying disturbing influences. Generally, therefore, the known system has limitations in itself, for precise weapon delivery.

It is therefore an object of the invention to overcome the various shortcomings in known arrangements. According to the present invention, there is provided a system for sighting targets comprising a helmet, a first detector and a second detector, the helmet including means for directing radiation from an eye of an observer wearing the helmet to the first detector to allow the latter to detect the position of the eye, the second detector being arranged to detect the position of the helmet, so that the position of a target viewed by the observer can be determined from signals produced by the first and second detectors.

By this means, advantage can be taken of the most natural human way of locating and tracking a target.

The human eye is a perfectly balanced organ, possessing a sufficiently good 'servo system' to damp out all but the most severe head vibrations. Unlike the requirements of existing systems, which use head position only, a more natural method of target tracking is to follow large target movements with the head and to carry out small adjusments with the eyes so as to maintain the point of interest on the most sensitive part of the optic nerve. During a concentrated tracking task, the eye is unlikely to move more than 10° from head centre-line. In short, the aircrew sight-line angle, measured in a way which best utilises the human facilities available, would consist of a 'coarse' contribution from head position and a 'fine' contribution from eye position.

One arrangement according to the invention will now be described by way of example with reference to the accompanying drawings.

The requirements of the eye position detector in this application are for a 10° angle of eye movement only, but since the system can be also usefully employed in establishing cockpit scanning patterns there may be advantage in accommodating an angle of 35°. Thus the system will establish a vector to the point of interest by a summation of head and eye positions.

Referring to the drawings:

Figure 1 is a diagrammatic arrangement of a known helmet-mounted sight.

Figure 2 is a diagrammatic arrangement of a helmet-mounted sight according to the invention.

Figure 3 diagrammatically illustrates the projected image of the iris on to a charge-coupled device (CCD) sensor through alternative angles of eye movement.

Figure 4 illustrates the resolution achievable in degrees of eye movement for each element of a charge-coupled device.

Referring to Figure 1, the pilot's line of sight 1 passes through a reticle 2 projected on to a parabolic section of visor 3. This line of sight to a particular target point, for example, is determined by means of a detector comprising a sight surveying unit (not shown) transmitting energy to sensors from which are computed helmet position and attitude, the data thus obtained being transmitted to the aircraft navigation attack system. A parabolic reflector 3*a* also on the visor 3 projects the reticle image and also permits the presentation of video or other data transferred on to its surface in collimated form from a cathode ray tube 6 by means of a lens system 4, a fibre optics bundle 5, an objective lens system 7, and an angled mirror 8. After reflection by the reflector 3*a*, a real image is formed at the central mirror 9 which itself reflects the light beam on to a partially reflecting parabolic section 10 of the visor 3, producing a collimated display visible to the pilot and superimposed on the natural scene viewed through the visor.

In Figure 2, which is a diagrammatic arrangement of the helmet-mounted sight according to the invention, the parabolic visor is substantially unchanged but the reticle projection 2 is omitted. A lightweight charge-coupled device (CCD) detector in the form of a camera 11 and an infra-red illuminator 12 are provided, the latter illuminating the eyeball, the camera 11 detecting its attitude or position by the varying reflectivity of the pupil 13. The image of the pupil 13 is reflected from the visor 3 to the mirror 9 and thence to the reflector 3*a*. The camera is installed to receive the image of the pupil 13 reflected from the reflector 3*a* by way of an angled dichroic mirror 14, which still simultaneously permits the passage of the collimated display in the reverse direction as described previously.

The natural infra-red radiation from the eye will be in the order of 10 microns but the CCD camera, to be compatible at this wavelength, would need to be cooled. The infra-red illuminator 12 proposed illuminates the eye at 1 micron which, although necessitating a further item of equipment, results in a simpler installation of better reliability.

The significance of the invention may be more clearly demonstrated by references to Figures 3 and 4.

Assuming the eye to have a diameter of 30 mm and an iris diameter of 10 mm the image can be projected via 1.5 to 1 optics on to a standard 25.4 mm square CCD display. Using this arrangement with a 200 x 200 CCD element then the resolution achievable can be expressed in degrees of eye movement for each element of the display affected. This is shown in Figure 4.

Thus converting the angle to the more usually specified mRadians the basic resolution is 5.6 mR per array element at the centre falling to 7.3 mR at 40°. The normal limit of eye movement tends to be about 35° but more normally is within 10° with the head providing the remaining movement. These accuracies are marginal for weapon aiming and figures of the order of 10 mR have already been obtained with prior equipment. Thus, with the probable accuracy of the combined helmet eye camera system resulting in a total 15 mR circular error probability the advantage in employing the eye camera system is not in accuracy but rather in the more natural use of human facilities resulting in faster acquisition and superior target marking with less concentration of effort. The system also allows fixes to be taken at significant angles from the head alignment which, although less accurate, offer advantages for the initial acquisition of targets and also for the analysis of cockpit workload. When the system is used to monitor pilot activity within the cockpit for workload assessment the effect of head translation becomes of importance but since the head movement is restricted by the environment, the accuracy will still be adequate to establish the instruments being viewed by the eye. For both inside and outside the cockpit the helmet-mounted sight also suffers from errors due to rotation of the helmet relatively to the head. The combination with the eye camera will tend to cancel out these errors.

WHAT WE CLAIM IS:

1. A system for sighting targets comprising a helmet, a first detector and a second detector, the helmet including means for directing radiation from an eye of an observer wearing the helmet to the first detector to allow the latter to detect the position of the eye, the second detector being arranged to detect the position of the helmet, so that the position of a target viewed by the observer can be determined from signals produced by the first and second detectors.

2. A system as claimed in Claim 1 including an infra-red illuminator mounted on the helmet for producing the radiation, the illuminator being arranged to transmit infra-red radiation to the eye, from which the radiation is reflected and directed to the first detector.

3. A system as claimed in Claim 1 or Claim 2, wherein the first detector is a charge-coupled device.

4. A system as claimed in any one of the preceding claims in combination with a data presentation system which includes a partially reflecting section of a visor of the helmet, and means to direct visual data onto

the partially reflecting section to present the data to the observer.

5. A system as claimed in Claim 4 wherein the means for directing the radiation to the first detector includes at least part of the means to direct the visual data to the partially reflecting section.

6. A system for sighting objects substantially as herein described with reference to Figures 2 to 4 of the accompanying drawings.

7. An aircraft including a system for sighting targets as claimed in any one of Claims 1 to 6, the system being arranged to provide signals to guide a navigation and/or attack system of the aircraft.

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1578136 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale

Fig.1.

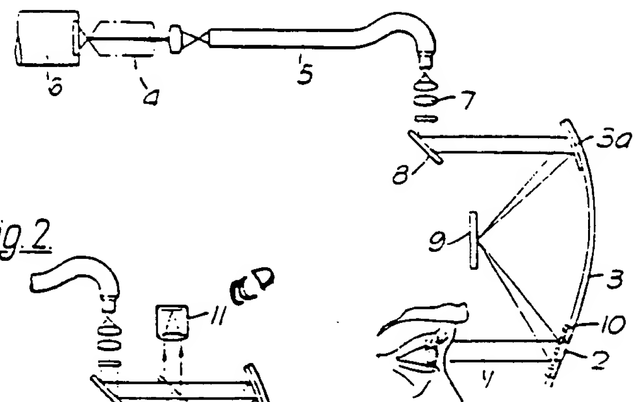

Fig.2.

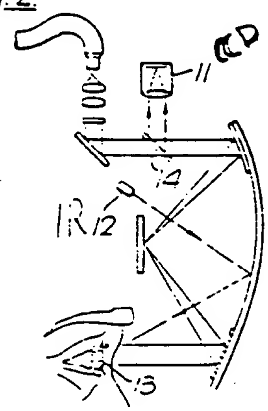

Fig.3.

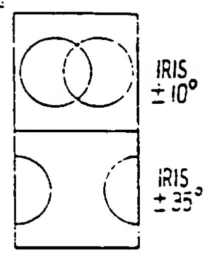

Fig.4.